

REMARKS

Claims 1-4, 6-8, 10-13, 15-19, 21-24, 26, and 27 are pending in this application. Claims 5, 14, and 20 were previously canceled and claims 9 and 25 are canceled herein. Claims 1, 6, 7, 8, 10, 16, 24 have been amended herein. In view of these amendments and remarks, Applicant respectfully requests reconsideration of the claims.

Claims 6-8 and 24 objected to because of inconsistency of terms. However, claims 6-8 have been amended so that the terms of the claims are now consistent.

All of the claims were rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,849,367 to Dixit, *et al.* (herein after referred to as Dixit, *et al.*) alone or in view of one or both of U.S. Patent Application No. 2003/0024902 to Li, *et al.* (hereinafter referred to as Li, *et al.*) and U.S. Patent No. 4,098,956 to Blickensderfer, *et al.* (hereinafter referred to as Blickensderfer, *et al.*).

Claims 9 and 25 have been canceled.

Applicants respectfully disagree that Dixit, *et al.* teaches all of the elements of claims 1, 3, 6, 10-12, 16-17, 21, 24, and 26 except that the plasma sputter is a radio frequency (RF) sputter. Actually, Dixit, *et al.* clearly teaches away from sputter cleaning of any type. As stated at column 3, lines 58-60, the purpose of the Dixit, *et al.* invention is to reduce the number of process steps. Therefore, an expert in the field would not even consider Dixit, *et al.* to arrive at the inventive method of a two step cleaning process that uses a sputter etch in combination with an anisotropic etch, since the purpose of Dixit, *et al.* is to avoid process steps.

It is widely known to use a sputter clean process to clean a deep hole or trench. However, the prior art sputter clean process generates particles that are problematic. These particles are displaced from the sidewalls to the bottom of the hole. In Dixit, *et al.*, this problem is solved by

using a plasma process to avoid generation of particles instead of a sputter process. In contrast to this, the subject matter of the present claims is directed to not only using a sputter process, but additionally using an anisotropic etch process to also etch the bottom portions of the hole.

More specifically, each of the independent claims now in the case require that a "sputter cleaning" process be used to remove the oxide on the surface of the conductive material at the bottom of the hole or via and further requires the use of an anisotropic, ion enhanced etch to remove organic material or particles displaced from the sidewalls to the bottom of the via or hole.

Dixit, *et al.*, does discuss the use of an initial sputter cleaning or etching with respect to a "prior art" process. See column 5, lines 36-52. It is also noted that the same paragraph clearly states that the sputter etch is for removing "impurities 40 (FIG. 1A) from the cavity wall 42", and that "Such impurities arise incident to the etch process" used to form the cavities (holes or vias) 28.

The other references to a sputter etch or cleaning process only discuss how the Dixit, *et al.* invention eliminates and/or replaces such a sputter cleaning process.

Specifically, column 3, lines 44-45 state that a cavity cleaning process "allows for the elimination of conventional sputter etch..." (emphasis added). Column 6, lines 16-20 states "The sputter etch described above is replaced by a low power plasma etch..." (emphasis added). Note the phrase "described above" in the previous quote is referring to a prior art sputter etch discussed at column 5, lines 36-47 not the process claims or taught by Dixit, *et al.* The last reference to a sputter etch states "In the operation of the invention, the cluster tool sputter etch station 44 is replaced with a plasma etch station..." (emphasis added).

Thus, the problem discussed by Dixit, *et al.* and the present invention may have some similarity. However, the solutions to solve this problem are entirely different.

In Dixit, *et al.*, a plasma etch (see FIG. 1A) is used for cleaning the sidewalls of the hole as well as for cleaning the bottom of the hole. This process may work with aspect ratios in the range of 5:1 (see column 6, line 23). At the time, the Dixit, *et al.* invention was made, greater aspect ratios did not exist for semiconductor vias and/or holes.

In modern semiconductor devices and especially in modern memory devices it is necessary to have very deep trenches for implementing the memory cavities and transistors therein. By further increasing the integration of the memory devices it is necessary that the structure width has to be further shrunk. This has the consequence that for a similar sized capacitor the depth of a trench has to be increased. Therefore, state of the art memory devices may have aspect ratios as great as 30 and more. Therefore, the Dixit, *et al.* process would not even work with most present day devices.

The inventive two step process according to the present invention, however, can clean deep holes with aspect ratios up to 30:1 and more.

This interrelationship is well known by an expert in the field of modern memory devices using deep trenches. Therefore, an expert in the field would not take Dixit, *et al.* in consideration to come to the subject matter of the present claims and especially to replace the required single step as disclosed in Dixit, *et al.* by the two steps of the present invention.

Further, it is seen that the Dixit, *et al.* reference teaches away from the clear requirements of the elements of the present claims. More specifically, the Examiners allegations at the middle of page 3 that the phrase "plasma sputter clean of the hole 28 to remove surface oxide..." was with respect to the prior art, and not only was not taught as being used in the Dixit, *et al.* plasma

process, but was explicitly replaced by the Dixit, *et al.* low power plasma etch. Likewise, the Examiner's reference to organic particles (described at page 3, second bullet) displaced from the sidewalls and deposited out at the bottom of the hole 28 during the "sputter clean" is improper since there was no sputter clean taught much less required by the Dixit, *et al.* method. As clearly stated only five lines above the Examiner's reference to column 6, lines 30-31, "the cluster tool sputter etch station 44 is replaced with a plasma etch station..." (emphasis added).

Therefore, it is respectfully submitted that claims 1, 3, 6, 10-12, 16-17, 19, 21, 24, and 26 clearly include limitations no where suggested by Dixit, *et al.* In fact, the requirement of the claim of sputter cleaning is specifically taught away from by Dixit, *et al.*

Although Li, *et al.* may utilize "RF" sputter for the purpose of cleaning organic residue and Blickensderfer, *et al.* may teach the use of nitrogen in a plasma, neither Li, *et al.* nor Blickensderfer, *et al.* over come the shortcomings of Dixit, *et al.* as discussed above and therefore it is submitted that the claims do now patentably define over the references of record and are allowable not only for their own limitations but for depending from a claim deemed allowable.

In view of the above, Applicant respectfully submits that the application is in condition for allowance and requests that the Examiner pass the case to issuance. If the Examiner should have any questions, Applicant requests that the Examiner please contact Applicant's attorney at the address below. In the event that the enclosed fees are insufficient, please charge any additional fees required to keep this application pending, or credit any overpayment, to Deposit Account No. 50-1065

Respectfully submitted,

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Date

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Amendment